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CONTENTS

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PARASITISM AS A FACTOR IN DISEASE[1]

THE study of etiology or causation is a study of the entire field of medicine from a certain point of view. Every phenomenon assumes an etiological aspect whenever we study it not as an effect to be simply contemplated and described, but as a cause or necessary condition of something that is going to happen. Provided with the information that for certain events to take place certain necessary conditions must precede, we can take steps by controlling the necessary conditions to allow the event to occur or not. Modern medicine has made the concept of causation its own. On it is founded all rational progress in prophylaxis and therapy. First to comprehend the cause, then to intercept and suppress it and thereby to prevent the next step is the kernel of medical science and practise. We project ourselves into the immediate future. The present is only the boundary between what has occurred and what is to happen. To control events we must know how to distinguish those conditions which are necessary from those which are merely associated and coincident.

The history of medical science, notably during the past half century, has clearly shown that observation of disease as it occurs in everyday life must be associated with the experiment. By observation I mean a survey or study of the phenomenon as a whole; by experiment, the observation of isolated parts of the entire phenomenon, the other parts being meanwhile eliminated or controlled by special devices. Observation and experiment, alternating, cooperating, and reacting on each other, are the only sure guides to a rational interpretation of disease. Nature is continu-

[1] Paper read at the annual meeting of the Association of American Physicians, May 10, 1921, as part of a symposium on etiology or causation of infectious diseases.

ally experimenting and observation is simply taking notes in this great life experiment. Without it the laboratory experiment would lack reality, for it is simply a page torn out of the book of nature with the unknown factors controlled or eliminated. To get at the facts of disease it has been found necessary to bring experiments as close as possible to the natural phenomena without losing control of the details.

The necessary association of observation and experiment in interpreting the conditions determining disease may be illustrated by the familiar one of the noise and the flash of gunfire. At a distance we see the flash and then hear the explosion. We might infer that the flash was a cause of the explosion, since it always precedes it. As we approach the scene of operations the noise follows the flash more and more quickly and close by the two reach our senses almost simultaneously. We then are in doubt whether the flash is a cause or merely an accompanying phenomenon. Our static observation at a distance fails to inform us correctly. The experiment of approaching the firing compels us to revise our original notion of causation and to make a further study of the entire phenomenon. The gist of the etiological problem is thus to determine what are necessary conditions and what merely secondary phenomena. The experimental method has been of immense service in laying bare the dynamic or causal relation, in other words, the true sequence of events. On the other hand, experiment too far removed from the actualities has frequently led astray when its results were too literally accepted and not controlled by observation of the entire phenomenon.

In the environment of man and within the human mechanism itself there are many conditions operative towards disease. This entire group or sequence of conditions, rather than any single factor in the group or sequence, may be regarded as the cause. If any one of these conditions is neutralized or controlled, the disease may not occur or if in progress it may take another course. Naturally these conditions have different values. They may be judged from their accessibility to control, *i.e.*, from a practical standpoint, or from the point of view of the physicist weighing them according to their energy values. We have hardly reached the stage, however, when the conditions favoring disease can be accurately measured. We must still deal with them as entities. Their qualities must engross our attention and their quantitative relations remain for a future, more exact medical science to weigh and measure.

The forces and conditions controlling disease are a mixture of heredity, environment, and parasitism. How can these factors be taken from their natural relations and studied individually without upsetting the delicate balances of causation? Where can we begin to test experimentally the observations we make about natural occurrences? Obviously some very careful surgical operation is necessary in carving out our field of work. In so doing we must realize that we become piece workers tinkering with only a part of nature's mechanism. Our finished product must be skillfully fitted into the larger mechanism. In attempting to limit our discussion to parasitism as an etiological factor in disease, I realize the difficulties mentioned. We have not only the different categories of environment, heredity and parasitism acting on one another, but within each category we have the animal body reacting with the factors like a chemical process swinging back and forth towards a state of equilibrium. Finally, we have in parasitism two living variable organisms capable of adjusting themselves towards each other in a remarkable degree.

When, about forty years ago, methods were devised by Robert Koch to make a beginning in the accurate study of bacteria as living agents of disease the contemporary scientific world realized that here were, to all appearances, agencies that could be separated from their environment, their life history and activities subjected to rigid investigation, and their relation to disease opened to demonstration. It is not surprising, therefore, that the bacteriologists of somewhat more than a generation ago, started on their way by these

methods, were inclined to regard the discovery of the pathogenic agent of some well-known disease as the beginning of the end of its prevalence. To have isolated, recognized, and cultivated a bacterium and produced some sort of pathological changes in an inoculated animal was considered equivalent to half or more of the battle won over the depredations of such organism. For many years these living agents, but more particularly the unicellular organisms among them, overshadowed all else and they became synonymous with the causes of disease. To-day we know that to have identified the microbic agent of any pathological process is but the beginning of the solution of the immediate problem and that it answers but one of a long series of questions. In spite of this somewhat discouraging fact, a very remarkable series of discoveries in the biology of disease have originated in this study of microorganisms. I need mention only the bringing to light of bacterial toxins, the discovery of their anti-toxins, hypersensitiveness or anaphylaxis, the phenomenon of acquired immunity and the collateral phenomena associated with it, such as the production of agglutinins, precipitins, complement-fixing bodies, and above all the specificity associated with the action of disease agents and the reaction of the host. Every one of these fundamental discoveries has had a far-reaching influence on the immediate development of the medical sciences. Every one in its way has dominated the thoughts and activities of large groups of investigators and there has resulted a very unequal, even chaotic, development of our knowledge of the conditions governing disease processes. Throughout this period dominated in turn by disinfectants, toxins, antitoxins, agglutinins, opsonins, complement fixation, and hypersensitiveness, there is evident some system, some purpose, and that is to find the exact place of living agents in the phenomenon of disease. From the more or less exaggerated point of view held at the start of their dynamic energy in the process there has been a more accurate, more scientific conception of their place as necessary conditions of disease making headway.

It is now evident that the relation of living agents, from the ultramicroscopic forms up to the higher parasites, is different for every agent or at least for every group of biologically related agents. We know now that the depth and extent of their etiological significance varies from an almost exclusive causation to one of relatively insignificant proportions. For the latter group the environmental and hereditary conditions completely dominate the situation and the particular germ found in one place may be replaced by others in another place. In most disease processes, therefore, the living agents are more or less governed by other factors. This is indicated by the great variation in the intensity of specific infectious diseases, by their seasonal appearance, by the sudden appearance and disappearance of outbreaks, and the difficulty of maintaining an epizootic among animals experimentally. Again, it is indicated by the difficulty of inducing disease with pure cultures in species of animals in which the disease occurs spontaneously and in the decline of virulence in artificial cultures.

Now it may be answered that when we fail to induce disease we do not know how to introduce the agent and where to deposit it. But the how and where are in themselves limitations of the activities of the specific agent. It may also be answered that the microbe with which we try to induce the disease has been attenuated by culture. True, the microbe needs the host to maintain its virulence. This is a significant limitation. Any one who has been confronted with a disease of unknown etiology and has in due time found the living agent knows how little or how much this means when he tries to construct the mechanism of the disease with its aid. In many cases the mystery remains as deep as ever until other necessary conditions have been isolated from the complex of causation.

Perhaps one of the most promising movements to bring into correlation with parasitism the other necessary conditions of disease is the study of epidemiology not from a statistical but from a biological viewpoint. To observe that of a given number of exposed

animals only a certain per cent. contract the disease and only under certain conditions inevitably leads to an inquiry into the causes other than the mere presence of infectious agents.

At this point it might be well to call attention to the necessity for including all invasive living agents however diverse in a study of the factors leading to disease and recovery. In pathology it has been customary to distinguish between parasitic invasion and bacterial infection, the former producing relatively slight disturbances in the host, the latter the acute, often highly fatal epidemic and epizootic diseases. The distinction is useful but it can be made to apply only to extremes. Gradations of all shades occur. For the sake of a more exact terminology, the distinction between invasion and infection might be made to hinge upon the capacity of parasites to multiply in the host. Thus the number of nematodes and related worms in the host is not larger than the number of fertile eggs introduced or of those individuals which actively penetrate as larvæ.[2] The formidable power of the infectious agents is due to their capacity for indefinite multiplication in the host. Sexual reproductive stages are not known. Certain protozoa such as sporozoa not only pass through sexual stages, but they may also multiply asexually and more or less indefinitely in the host tissues. They may be considered both invasive and infective. It is thus best to class all living invasive organisms as parasites, subject more or less to the same host mechanisms of repression and destruction. At one end of the scale are the highly specialized forms, adapted to one host species or even one race. At the other end are types emerging from the predatory or saprophytic stage and acquiring parasitic habits.

Another concept which we as medical men should have clearly before us is that the phenomena which medical science is chiefly interested in, namely, those of disease, are merely epiphenomena in an evolving parasitism, by-products which tend to lessen and disappear as the parasitism approaches a biological balance or equilibrium. How rapidly this evolution may progress we have no means of knowing. We do know that among animals epizootics tend towards a lower level of mortality and morbidity. If we are actually studying by-products, it is obvious that to understand them we must first understand the main processes that give rise to the by-products and that disease is studied most successfully by studying the necessary conditions that give rise to it. If the by-products are in themselves necessary antecedents of other pathological conditions, they would of necessity be included in any study of causation.

A sufficient number of living agents of disease and of parasites has now been studied to permit a tentative classification into highly specialized parasites adapted to and dependent on a given host and those that are more or less predatory, awaiting adaptation provided their organization should permit it. The highly adapted microorganism which depends upon one host for its existence, as, for example, the still unknown smallpox organism, has through natural selection established between itself and its host a certain balance or equilibrium. This can be defined as a condition of both host and parasite which permits the latter to enter the body, multiply enough and escape so that the arrival of its progeny in another host is assured. On the basis of this relationship we may define four critical phases in the life cycle of the microbe: first, its entry into the body and through protecting tissues; second, its transportation to and multiplication in certain tissues; third, its escape from those tissues and from the host as a whole; and fourth, its transfer to another host. Each one of these phases is capable of subdivision into a larger or smaller number of sequences according to the special living agent involved. In the insect-borne diseases the insect acts as transfer agent and as introducer into the blood. The fourth and the first stage merge. In general the fourth stage, or stage

[2] We must except from this broad statement the nematodes of the genera filaria and trichinella since their progeny develops within the same host to the larval stage and stops there.

of transfer from one host to another, has been greatly modified by civilization. It is therefore necessary in any attempt to formulate the problems of etiology to take into consideration the primitive conditions under which the infectious diseases originally flourished and from which they have come down to us. We do not know whether they originated with man or earlier among his progenitors. But it is safe to take the ground that infectious diseases flourished among the earliest races and that they flourish to-day among savage and semicivilized peoples as they do among domesticated animals in our midst. That is to say the infectious agents developed in an environment in which transfer from host was direct, immediate, and easily brought about. Furthermore, the infusion of susceptible subjects, except during wars and migrations, was slight. These two conditions tended to counteract one another and to bring to an approximate perfection the parasitic habit of the invading organism.

It is this fourth stage of transfer that engaged the entire attention of the early bacteriologists. They created the era of isolation and disinfection by improving diagnostic methods and studying the modes of exit of infectious agents and their resistance in transit. It was tacitly hoped and expected in this great work that infectious diseases could be easily controlled and suppressed by destroying the agents in the environment of the sick. The science of one generation becomes the practise of the next. Disinfection, isolation and the widening of the danger space between the sick or infected and the well is the chief occupation of modern sanitation. The actual significance of this practise needs to be evaluated from time to time if only in the interests of economy of effort. While it is generally conceded that the movement of the agents of disease should be restrained as much as possible and while heroic efforts are being made to this effect by health officials, economic forces are driving people together and condensing populations and thereby largely neutralizing the efforts of sanitarians. If any value can be put on this work at present, it might be to the effect that it tends to keep individuals from getting an overdose of infection.

When we come to the first phase in the cycle, the entrance of the virus into the body and its penetration through the skin and mucous membranes, our knowledge is on the whole neither accurate nor abundant. While the fourth stage has been pretty thoroughly exploited, the first is hardly at all known in its details. Each well established infectious agent will have its own story to tell of this phase. In extenuation of the deficiencies of our exact knowledge it should be stated that the problem is a very difficult one. Microorganisms leave the body in armies, having multiplied to supply a progeny ample to cover losses in transit. On entering only single individuals or small groups are involved and unless their morphology is characteristic, like that of the sporozoa and the metazoan parasites, the entry is well beyond the ken of the observer. It can only be got at indirectly. The difficulties of this stage are well illustrated by the prolonged discussions concerning the entry of tubercle bacilli. Much has been done and written in the attempt to clarify this problem. The doctrine of the inhalation of dried bacilli in dust, the droplet infection of fresh sputum, and the theory of the alimentary origin of infection have had their day in court. Similarly the portal of entry of the virus of the eruptive diseases has been the subject of much study and discussion.

The penetration of living agents through the skin and mucous membranes is full of unanswered questions. The resistance of the normal mucous coverings has probably been greatly underestimated. The effect of injuries in removing this barrier has been similarly underestimated. From a practical standpoint this problem may seem academic since the mucous coverings for example may rarely be free from minor lesions and such lesions may remain, at best, undetected. But the object of genuine medical science is to get away from the benumbing influence of such consideration. Do typhoid bacilli, for instance, penetrate the normal mucosa, or are they dependent on slight lesions? Do protozoa assist them

at certain seasons? Do phagocytes ever migrate out under normal conditions and carry bacilli back into the tissues? Might this take place when inflammatory processes are active? Is the entry of certain viruses prepared by other viruses acting only on the epithelium and destroying it or in some other way making the tissues involved more vulnerable? Epithelium-destroying parasites are well known among the sporozoa. It is not improbable that other types of microorganisms, especially those not within the range of the microscope, are specifically adapted as genuine parasites to invade these cells and so prepare the way for the saprophytic, predatory types which are readily recognized because easily cultured and therefore regarded as summing up the entire etiology.

After the living agencies have entered the tissues they must run the gauntlet of the blood, lymph, and the phagocytic cellular elements to reach those tissues where they multiply. Multiplication is essential, for a large progeny is necessary to cover the losses in transit. This stage of multiplication involves the problem of specific resistance or immunity and susceptibility, and also the practical problem of treatment by therapeutic agents, serums, vaccines, and the like. The biological requisite to be fulfilled by the parasite in this second stage, or stage of multiplication and sexual development within the host, if such a stage exists, is that multiplication must take place in such a way that escape in large numbers from the host after the parasites have assumed a more or less resistant form becomes possible. This is best accomplished when they settle down and multiply near some portal of exit, first the skin or subcutis, second the respiratory tract, third the digestive, and fourth the genital tract. A brief consideration of the localization of the different groups of parasitic agents will show that these various superficially located tissues are the chief seats of multiplication. Localization in other tissues or organs is rare and so far as the parasite is concerned abnormal. If it should happen that a race of *Treponema pallidum* arose which promptly and exclusively localized in the central nervous system, it would die out for want of an exit to another host. The tendency to locate and multiply in tissues of lower vital dignity, *i.e.*, near the surface of the body or the mucous membranes, safeguards the host as well as the parasite.

Among the parasitic invaders of man and the higher animals the metazoan and protozoan parasites have developed relatively perfect, in some cases complicated cycles. The same is probably true of those highly specialized microorganisms which produce the eruptive diseases and of some of the so-called filterable viruses. In fact, all diseases or parasitic states which maintain themselves indefinitely in a host species and are manifestly transmitted from case to case have complete, even though not necessarily elaborate cycles.

The tubercle bacillus is frequently referred to as a highly adapted parasite, but its parasitism is crude compared with that of the smallpox organism. It has no well-defined cycle except in phthisis, in which it is inhalation and expectoration. If for the sake of illustration we conceive the primary lesion as leading in every case to a secondary miliary tuberculosis in which there is extensive invasion of the skin with subsequent ulceration, the tubercle bacillus would then be inhaled and after multiplication shed from the skin, in so far approaching the smallpox organism in its cycle. But there is no indication that such a complete cycle ever will be established. On the other hand, the leprosy bacillus appears to have in a bungling way reached this stage, for the shedding of leprosy bacilli takes place from skin and mucous membranes, notably, of the nasal passages.

In certain cases the cycle is limited to a mucous membrane parasitism and the disease is the result of a diversion of the organism into the tissues of the body. The cycle of the typhoid bacillus may be some locus of the digestive tract with incursions into the blood. Whether the invaders perpetuate themselves, *i.e.*, escape again, depends upon ulceration of the lymphoid tissue of the intestines. The meningococcus resides in the upper respiratory tract. We do not know whether the cocci

which enter the central nervous system escape or not. This is an important question for it is probable that the degree of virulence of the microbe depends upon some contact with the host tissues more intimate than that of a mere saprophytic existence in recesses of the mucous membranes. If such an organism could associate itself with some living or dead factor which assisted its entrance and exit, a definite disease might thereby become established, and we might expect the disease to rise and fall in epidemic style according as the helping factor is active or not. Contact with and multiplication in living tissues, either cellular or humoral, appears furthermore to stabilize the microorganism. If we look over the immunological and serological data which have accumulated about the various groups of parasitic agents we find the relationships established by these reactions much more uniform among strictly invasive than among the secondary organisms which depend upon formidable factors to open the way into the system for them. Or to put it another way, there is a much larger number of serological types among the hangers-on than among those capable of direct invasion.

If the picture I have drawn of the parasitic cycle is fairly accurate, it follows that the localization of disease agents or parasites in all tissues and organs except those from which ready escape to the exterior is possible is abnormal and unnecessary for the continued existence of the parasite. Hence, typical, characteristic, recurring infectious or parasitic diseases affecting the central nervous system, the ductless glands, the liver and kidneys, the muscular system and the joints do not occur excepting as secondary localizations of diseases involving the more external tissues. If such localization should occur regularly without some superficial localization as well, we must look for some source of infection belonging to another species in which the cycle is normal and from which a constant supply of parasites is available even though they fail to escape from the new host. The invasion of the human body by the bovine tubercle bacillus is a familiar case in point. In some infectious diseases several invasions of the same host may be necessary to bring the parasitic cycle to completion or, viewed from a medical standpoint, to bring the disease to the clinical level. In bovine tuberculosis, which can be studied anatomically and topographically by killing animals in early stages, the first tubercle bacilli to enter the system usually land directly in regional lymph nodes. To complete the cycle the virus must enter the blood and establish secondary foci in lungs or other tissues from which the bacilli may escape to another host. The cycle is, however, more easily explained by reinfection. The inhaled bacilli lodge now in the lung tissue due to a changed reaction of the host tissues at the point of entry and the cycle—inhalation and expectoration, assisted by discharge in the feces through swallowing the sputum—is established.

There are two factors that may modify the normal cycles more or less. One is a relative immunity, which may be either natural or acquired. Through immunity cycles may be cut short chiefly in the stage of multiplication and the parasite fail to escape at all or in sufficient numbers to maintain further existence. If for any reason the normal resistance of the host is reduced, the parasite may multiply unduly or invade more territory and cause death of the host before the cycle is completed. This condition may be explained by regarding parasitism not as a condition of peace but of armed truce. As soon as one of the two organisms falls below a certain level, the other takes the advantage. In case the microorganism gets the advantage, it may be fatal for both host and parasite. This latter condition of reduced natural resistance is supplied by civilization either by bringing into the original disease other parasites and greatly complicating what might have been a simple situation, or else by conditions arising from inherited defects, over-exertion, abnormal diet, exposures to heat, cold, which are supposed to favor the parasite in its entry and multiplication. These conditions furnish the many modifications of disease types which may be as varied as the number of individuals at-

tacked. It is this increasing complexity of affairs which supports from the scientific side the dictum that the physician is to treat the patient rather than the disease for there is no longer a type disease to be recognized regularly.

This brings us back to the original subject of etiology. A careful biological study of the many parasitisms of man and the higher animals brings out the fact that the highly specialized parasites have no obstacles to their activity, except one and that is immunity, either acquired or natural. As a result all host individuals pass through the disease early in life provided opportunity for invasion is given. The highly specialized diseases tend to become, in endemic localities, children's diseases.

In the case of many other diseases certain non-parasitic factors are necessary to start the disease or to check it, as the case may be. They are part of the mechanism of causation and represent necessary conditions. These necessary conditions may far outweigh the living agents in etiological significance. The relative importance of the living factors may be so low that their place may be taken by other living agents or even non-parasitic factors in the sequence leading to or continuing existing disease processes. This is probably true of certain diseases of intestinal origin. Such diseases are frequently described as due to different microbic agents in different localities because the endemic flora happens to be different.

The relation between the factors of parasitism on the one hand and those of heredity, environment and the like on the other may be briefly summarized as follows:

In the saprophytic or predatory type representing the so-called septic infections the other parasitic and non-parasitic factors are of great, even predominating importance in the production of disease.

In the highly parasitic type they are of little, if any, importance unless it be hereditary characters brought out by the selective action of the parasites themselves upon the host species through many generations. Many gradations exist between these extremes and the relation of parasitic to extra-parasitic factors is different for the different grades.

Moving parallel with the degree of adaptation and specialization and the development of more nearly perfect cycles by the parasites the mortality drops and the morbidity at first spreads and finally tends to decline in certain types of parasitism, provided always that other types of parasitism do not accidentally enter to modify and complicate the normal course.

In tracing the various living agents through the body of the host we find that we do not know the details of any parasitism to our satisfaction. These details, of course, include also the non-parasitic factors or conditions essentially favoring or hindering the parasite in its sojourn in and its journey through the host tissues. It is perhaps needless to refer at length to the conditions which control the acquisition of such knowledge. The hope of finding some preventive or cure dictates the course of many workers. When something approaching this has been found the etiological significance of all the other factors bearing on the disease falls below the horizon for the time being. The importance of continuing the study of the disease persists however even for practical reasons, for the remedy or preventive may not prove to have the success anticipated. To induce men to fill the gaps of our knowledge seems quite as important as the pioneering for entirely new vistas or outlooks. Great discoveries are, as a rule, half-truths that must be brought into line by patient after-research. The filling of gaps may be necessary to stage the next great discovery.

There is beyond the mere knowledge that gaps exist the difficulties of the problems involved to be considered. Are we prepared to solve them directly or must we rely on indirect approaches and on the solution of analogous problems to satisfy our etiological sense? Added to these difficulties inherent in some phases of the parasitic cycle, notably that phase which takes place within the host, is the fact that the various disease agents attacking the same species, man for instance, are so different from one another that we may safely

consider them surviving types. It would seem that where two or more parasites follow the same route and multiply in the same tissues a certain competition tends to eliminate one or the other. If two closely related types exist they rarely multiply in the same host at the same time. Such competitive elimination would leave a divergent assortment of parasitic organisms and resulting diseases, none of which would be an exact copy of the other. In this case the working out of one cycle does not necessarily enable us to predict what another would be. They must each and all be studied individually.

In this dilemma we may gain assistance from a study of parasitisms in those remote and isolated regions which have not yet been seeded by the white man's diseases, where the prevailing maladies may still be "pure lines," rather than mixtures and combinations. Another source of material are the many characteristic parasitisms of animal life, notably of the mammals and birds. Comparative pathology may furnish us with that information which experimental pathology finds it impossible to produce. Taking all the diseased and abnormal states due to living agents in man and the higher animals together, a series may be established which fills in many gaps and which may furnish the suggestions and clues needed to bring about a better insight into the dynamic relations between host and parasite. Only through the cooperation of comparative and experimental methods may we hope to gain enough general underlying concepts to explore with some show of rationality new diseases successfully. Since science is valued in proportion to its capacity to predict successfully certain events, medical science will be judged by the way it takes hold of a new phenomenon to determine its etiological antecedence. If, in the course of its development, it has failed to take cognizance of factors necessary to build the science into a consistent whole, it should retrace its steps and make up the deficiency.

Parallel with the continued analysis of phenomena there should be another process going on to simplfy the complexity resulting from the former and to bring the results of scientific inquiry more or less within the reach of everyday life. What is needed is a synthesis of the many data resulting from analytic study of phenomena. Perhaps I can make myself clearer by using as an illustration some recent investigations. If we examine the various diseases in which the virus is conveyed by insects and arachnids, we shall find that many of the data pertaining to the dissemination of the virus had been accurately worked out before the mode of transmission was discovered. There was lacking, however, a something to harmonize and coordinate them. When the insect carrier was defined these various discrete, apparently unrelated data fell into line. Here was a synthesis which not only substantiated older observations but it enabled the scientist to use the deductive method to develop new inquiries and thereby lift the subject up to a higher level for further analysis. For some years we had known that a certain disease of young turkeys, due to the invasion of the tissues through the intestinal tract by a protozoan parasite, could be prevented by raising these birds away from older turkeys and common poultry and on soil uncontaminated by them. The explanation came through the discovery that a common worm of these species was needed to injure the mucous membrane and thereby open the way for the protozoan parasite. The nematode also accounted for certain disturbances in the application of the above rules in the rearing of these birds. It synthesized, in other words, the accumulated data.

With the aid of these illustrations it is possible to understand, at least in part, what must have been the effect of the rapid discovery of various living agents in the eighties of the last century on the medical mind of the period. Many apparently unrelated data suddenly moved into line and assumed definite relations to one another. The discoveries pertaining to acquired resistance to disease involving the action of antitoxins, agglutinins, precipitins and the like have not had as yet the desired effect of synthesizing the conception of immunity, because they may be ac-

cessories rather than essential factors, all grouped around some more fundamental, unifying, still undefined phenomenon.

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THE FIRST APPEARANCE OF THE TRUE MASTODON IN AMERICA

I HAVE recently published a paper[1] under this title, naming one species *Mastodon matthewi* from the Lower Pliocene of Snake Creek, Nebraska, and another species *Mastodon merriami* from what I supposed to be the Middle Pliocene of Nevada, in honor of Dr. William D. Matthew and Dr. John C. Merriam, respectively.

I have just learned from Dr. Merriam that *Mastodon merriami* is not, as I supposed, of Pliocene but of Middle Miocene age, which makes this species all the more important and interesting as the first to reach America. Dr. Merriam writes, June 24, 1921:

> The locality described by Mr. Hills, namely, that at which G. D. Matheson secured his material, is, however, in the Virgin Valley formation, which is of approximately middle Miocene age, not far from the zone of the Mascall of the John Day region. The opal mines are in the Virgin Valley formation and lie between the two main forks which unite to form Thousand Creek. These streams are Virgin Creek and Beek Creek. They unite on the west side of the great Rhyolite mass which separates the lower part of the Virgin Valley beds from the areas of the Thousand Creek formation lying to the east. The change in the age of *Mastodon merriami* suggested by the data given above will, I am sure, interest you greatly as this evidently brings the appearance of these Mastodons back to near middle Miocene.

I am greatly surprised and interested by the Middle Miocene appearance of the true mastodons in America, if the above report by Dr. Merriam is correct, as I have no doubt it is. Middle Miocene age is, in fact, quite consistent with the structure of the superior canine tusks, which bear a broad enamel band on a *concave* outer side, a fact that puzzled me greatly because Dr. Schlesinger describes the Lower Pliocene mastodons of Hungary as bearing an enamel band on a *convex* outer surface. We should expect the earlier mastodons to show just the difference in the curvature of their tusks which these two observations would indicate.

It now seems that the true mastodons may be traced back to the species *Palæomastodon beadnelli* Andrews, living along an ancient river corresponding to the Nile, in company with a primitive long-jawed proboscidean to which Andrews and Beadnell gave the name *Phiomia serridens* in 1902. This was in Upper Eocene or Lower Oligocene times. In Lower Miocene times the true mastodons appear in North Africa and reappear in the Middle Miocene of France, although far less abundant than the contemporary species of long-jawed animals named *Mastodon angustidens* by Cuvier, which are descended from *Phiomia*. The rarity of the true mastodons is attributable to their strictly forest-living habits. They occur rarely in the Miocene and Lower Pliocene of France and Switzerland, also in Austria as recently described by Schlesinger of Vienna.

If the *Mastodon merriami* of Nevada proves to be of Middle Miocene age, it will demonstrate that these true mastodons came to this country much earlier than we have been led to suppose. The earliest arrivals hitherto recorded in this country are the *Mastodon brevidens* and *M. proavus* of Cope, which hailed respectively from the Middle Miocene of Oregon and of Colorado. It is not yet positively known whether these two species are true mastodons or representatives of one of the other phyla.

HENRY FAIRFIELD OSBORN
AMERICAN MUSEUM OF NATURAL HISTORY,
June 29, 1921

[1] *Amer. Mus. Novitates*, No. 10, June 15, 1921.

SCIENTIFIC EVENTS

THE SCIENCE CLUB OF THE UNIVERSITY OF MISSISSIPPI

DURING the academic year 1920–21, the Science Club of the University of Mississippi,

composed of members of the science faculties, held seven meetings. The following papers were presented:

Oct. 1920. Tabulated results of questionnaire circulated among students the previous year to ascertain student attitude toward marriage, by H. R. Hunt, Ph.D.

Nov. 1920. Some phases of American archæology (lantern demonstration), by Calvin S. Brown, Sc.D.

Dec. 1920. Intestinal intoxication as a bacteriological problem, by Paul R. Cannon, Ph.D.

Jan. 1921. Tabulated results of physical examination of students, with discussion, by Byron L. Robinson, M.D.

Feb. 1921. Petroleum, with particular reference to its presence in Mississippi (specimens demonstrated), by J. N. Swan, Ph.D.

Mar. 1921. Influenza, case citations and brief review of literature, by Whitman Rowland, M.D.

April 1921. Malaria, its incidence and control, by W. S. Leathers, M.D.

Throughout the past year the club has extended the privilege of its meetings to advanced students, and with very gratifying results.

C. F. DE GARIS,
Secretary

THE WORK OF THE ROCKEFELLER FOUNDATION

A REVIEW of the work of the Rockefeller Foundation, issued by the president, Dr. George E. Vincent, summarizes as follows the activities of the Rockefeller Foundation, the International Health Board, the China Medical Board and the Division of Medical Education:

Aided six medical schools in Canada.

Gave a large sum to a medical training center in London.

Appropriated 1,000,000 francs for the Queen Elisabeth Foundation for Medical Research in Belgium.

Agreed to contribute toward the complete rebuilding of the medical school of the University of Brussels.

Provided American medical journals and laboratory supplies for ten medical schools and medical libraries in five European countries.

Continued to construct and maintain in Peking, China, a modern medical school with a pre-medical department.

Aided thirty-one hospitals in China to increase their efficiency in the care of patients and in the further training of doctors and nurses.

Supported the School of Hygiene and Public Health of the Johns Hopkins University.

Contributed to the teaching of hygiene in the medical school at Sao Paulo, Brazil.

Provided fellowships in public health and medical education for ninety-three individuals who represented thirteen different countries.

Brought to the United States commissions of medical teachers and hygienists from England, Belgium and Czechoslovakia.

Continued to support a campaign against yellow fever in South and Central America and in West Africa.

Aided Government agencies in the control of malaria in ten states of the South.

Prosecuted hookworm work in ten southern states and in eighteen foreign countries.

Helped to expand anti-hookworm campaigns into more general health organizations in counties, states and nations.

Brought a wartime anti-tuberculosis work in France to the point where it could soon be left entirely in French hands.

Assisted the Government of Czechoslovakia to reorganize its public health laboratory system.

Rendered various services in organizing committees to study the training of nurses and of hospital superintendents, lent experts for conference and counsel, sent officers abroad to study conditions, etc.

Brought to a close its participation in wartime emergency relief by giving $1,000,000 to the fund for European children.

THE EXPOSITION OF CHEMICAL INDUSTRIES

As has already been noted in SCIENCE, the Seventh National Exposition of Chemical Industries will be held at the Eighth Coast Artillery Armory, New York City, during the week of September 12. According to an announcement issued by the directors, the growth of the Chemical Exposition during the last seven years has been a barometer of the trend of public thought and interest in America's scientific achievements. Manufacturers, engineers, scientific men and students are drawn toward these remarkable displays from all corners of the country. It has therefore be-

come necessary to stage the 400 exhibits of this year's event in an exposition building of immense proportions, covering an area of five city blocks. As much of the program is carried out in speeches, lectures, and papers of value to the investigator along these lines, a special auditorium arranged according to the plan of a theater, and having a seating capacity equal to many such houses, will meet the needs of a quiet and comfortable lecture hall. It will offer an ideal place for the many symposiums that will be held during the week.

These will take the nature of scientific discussions, practical talks, exchange of ideas, "get together" meetings, and motion pictures covering every industry, lent through the courtesy of the government, numerous companies and plants where these industrial reels have been filmed.

Dr. Charles H. Herty, editor of the *Journal of Industrial and Engineering Chemistry,* is chairman of the advisory committee. Others on this board include Raymond F. Bacon, director, Mellon Institute; L. H. Baekeland, hon. professor chemical engineering, Columbia University; Henry B. Faber, consulting chemist; John F. Teeple, president, the Chemists Club; Bernard C. Hesse, chemist, General Chemical Co.; Acheson Smith, president, American Electrochemical Society; A. D. Little, president, Arthur D. Little, Inc.; William H. Nichols, chairman of the board, General Chemical Co.; H. C. Parmelee, editor, *Chemical and Metallurgical Engineering;* Fred W. Payne, co-manager of the exposition; R. P. Perry, vice-president, The Barrett Co.; Charles F. Roth, co-manager of the exposition; Edgar F. Smith, president, American Chemical Society; T. B. Wagner, vice-president, U. S. Food Products Corporation; David Wesson, president, American Institute of Chemical Engineers; and M. C. Whitaker, president, United States Industrial Chemical Company. The headquarters of the exposition are now located at 342 Madison Avenue, New York City.

THE CHEMICAL MEETING IN NEW YORK CITY

Governor Miller will go on Labor Day to Niagara Falls to welcome officially the delegates of the British Society of Chemical Industry, who will visit the United States to hold a joint meeting with the American Chemical Society. At the head of the overseas delegation will be Sir William J. Pope, president of the Society of Chemical Industry. Among other prominent members will be Dr. Louis A. Jordan, who was sent to aid the Italian government in the making of explosives; Dr. Frederick William Atack, whose principal work has been the chemistry of dyes; Dr. Andrew McWilliams, one of the best known steel metallurgists in Great Britain; and Dr. Andrew Smith, an explosives engineer of international reputation. Some of the eminent Canadian chemists will be: Dr. R. F. Ruttan, past president of the Canadian Section of the society; Dr. Milton L. Hersey, one of the founders and past chairman of the Canadian Section; and Dr. C. R. Hazen, chairman of the Montreal Section.

According to the preliminary program of the American Chemical Society, made public today, registration begins at the Chemists Club, 52 East 41st Street, on Tuesday, September 6. The dinner of the Council will also be held at the club. The general meeting will convene at 10 o'clock on the following day at Columbia University, and at half past twelve o'clock the Society of Chemical Industry's luncheon to British and Canadian visitors will take place. There will be a reception and lawn party for the members of all societies concerned, to be held on the Campus of Columbia University, and in the evening a smoker will be held in the Waldorf-Astoria.

A joint meeting of the American Chemical Society and of the Society of Chemical Industry of Great Britain has been arranged for four o'clock on Thursday afternoon and in the evening will be held a banquet at the Waldorf-Astoria. The various divisional and sectional meetings are scheduled at Columbia University. The sessions will conclude with a public meeting, at which the president, Dr. Edgar F. Smith, will deliver the annual address. The last day will be given to excursions to various chemical plants and other points of interest in the city.

SCIENTIFIC NOTES AND NEWS

Sir Joseph Thomson has been elected honorary professor of natural philosophy and Sir Ernest Rutherford professor of natural philosophy at the Royal Institution.

The Osiris prize of 100,000 francs has been awarded by the Academies of the Institute of France to General Ferrié, director-general of French military telegraphs, in recognition of his work in the development of wireless telegraphy for war purposes.

We learn from *Nature* that at the annual visit to the National Physical Laboratory of the members of the General Board on June 28 a bas-relief in bronze of the former director, Sir Richard Glazebrook, was presented to the laboratory. The presentation was made by Sir Joseph Thomson and received on behalf of the laboratory by Professor Sherrington, president of the Royal Society.

Dr. Michael E. Gardner has been appointed chief of the bureau of preventable diseases and director of the bacteriologic laboratory of the United States Public Health Service.

Dr. J. H. Shrader, formerly of the United States Department of Agriculture, has been appointed director of the Bureau of Chemistry and Food, Health Department, Baltimore, Md.

Charles Y. Clayton, professor of metallurgy at the Missouri School of Mines, is working at the laboratory of Dr. H. M. Howe at Bedford Hills, N. Y., during the summer.

Olaf P. Jenkins, associate professor of economic geology at the State College of Washington, is in charge of the field work for the Washington Geological Survey and is investigating certain road materials, the Grand Coulee as a reservoir site, and the iron ores of Washington in relation to the possible manufacture of iron and steel.

Harlan I. Smith, of the Victoria Memorial Museum, Ottawa, Canada, is now in the field carrying on the investigations of the ethnology of the Bellacoola Indians of British Columbia which were begun by him in 1920 under the auspices of the Geological Survey of Canada.

The annual meeting of the French Association for the Advancement of Science is being held this year at Rouen from August 1 to 6.

The Municipal Observatory at Des Moines, Iowa, which is said to be the only municipal observatory in the world, was opened on August 1. The observatory building is to be equipped by Drake University with an 8-inch equatorial telescope. It is to be under the control of the university and open to the public at least three times a week, and at any other time when occasion may warrant.

A new forest experiment station, the first in the Eastern States, has been established at Asheville, N. C., by the Forest Service of the United States Department of Agriculture. Steady depletion of the Southern Appalachian timber supply has been responsible for the location of this station in the East, and the object of the work to be conducted will be to secure the information needed by foresters to determine the best methods of handling forest lands in the southern mountains.

The Swedish Academy of Sciences has asked the government to set aside a million and a half kroner from the private funds of the Nobel Foundation and apply the interest to the Nobel prizes as owing to the depreciation of the Swedish krona the recipients of the prize do not receive the former value.

The French Academy of Medicine has received a donation from the widow of the Marquis Visconti to found a triennial prize of 3,000 francs in memory of Infroit, the radiologist.

The school of mines of the College of Engineering of the University of Alabama offers five fellowships of the value of $540 in mining and metallurgical research in cooperative work with the U. S. Bureau of Mines. They have been established for the purpose of undertaking the solution of problems being studied by the U. S. Bureau of Mines that are of especial importance to the State of Alabama and the Southern States.

The members of the American Chemical Society were informed of the printers' strike and the action of the council regarding it in the May issue of the *Journal of Industrial and*

Engineering Chemistry. The secretary writes: "The May *Journal*, the May and June *Industrial Journal*, and the May 10 *Abstracts* have been mailed to members. The June *Journal* and May 20 *Abstracts* are about to be mailed. The July *Industrial Journal* will follow soon. Our publishers report that they now have a full corps of men, although somewhat inexperienced in chemical printing. They state that as far as they are concerned the strike is over, and there will be no increased printing costs to the society, but that it will take them a few months to get back on the very prompt schedule that they have given us for many years past. Members are asked to be patient regarding the receipt of their journals with the assurance that in a few months everything will be normal again."

WE learn from the *British Medical Journal* that the expedition sent to British Guiana by the London School of Tropical Medicine to investigate filaria has been at work since the middle of April. It was dispatched at the request of the then Secretary for the Colonies, Lord Milner, who considered that further information was required as to the best method of controlling filariasis. The leader of the expedition is Professor R. T. Leiper, director of the helminthology department of the London School of Tropical Medicine; he was accompanied by Dr. John Anderson, Dr. Chung Un Lee, and Dr. Mahomed Khalil of the Egyptian Medical Service; Dr. G. M. Vevers, demonstrator of helminthology in the London School of Tropical Medicine, will leave England to join the expedition very shortly. It was originally arranged that the expedition should last for six months, and at the suggestion of Sir Patrick Manson it is proposed that visits shall be paid to certain West Indian islands, choosing one, such as Barbados, where the rate of attack is high, and another, such as Grenada, where it is low. It is hoped that by comparing and contrasting the circumstances of two such islands light may be thrown on the conditions which favor the filaria.

THE New York State Association of Consulting Psychologists has been established. The purposes of the organization are: "The promotion of high standards of professional qualifications for consulting psychologists" and "Stimulating research work in the field of psychological analysis and evaluation." Membership is limited to those who have the minimum requirements of two years graduate work in psychology. The Executive Committee for the current year are: David Mitchell, President; Louis A. Pechstein, vice-president; Elizabeth A. Walsh, secretary-treasurer; Elizabeth E. Farrell, Samuel B. Heckman; Leta S. Hollingworth; Robert S. Woodworth. The association has already begun active work and is making psychological examinations of children, and the Department of Education plans to organize classes on the basis of the results secured through the psychological examinations.

THE committee appointed to judge the scientific exhibit at the Boston meeting of the American Medical Association, which consisted of Dr. W. B. Cannon and Dr. G. W. McCoy, has awarded a gold medal to Dr. Kenneth M. Lynch of the department of pathology of the Medical College of the State of South Carolina, for his exhibit of photographs and microscopic preparations illustrating investigation of ulcerative granulomata. Certificates of merit are awarded to Dr. V. H. Kazanjian of the Harvard Dental School for his exhibit of plaster masks, casts and photographs of war injuries to the face and jaws, and Drs. Mendel, Osborne and Bailey of the Connecticut Agricultural Experiment Station for their exhibit illustrating the effect of different qualities of protein upon growth.

DR. LYNDS JONES, of the department of ecology of Oberlin College, is in charge of a scientific expedition into the northwestern part of the United States. Five men and eleven women research students will make a tour in specially prepared Ford cars, with complete camping outfit. Starting at Grinnell, Iowa, the party will visit Lake Okoboji, and will then go through Minnesota along the old Yellowstone Trail. Special stops will be made at Aberdeen, South Dakota, and Billings, Montana. After visiting the Glacier National Park a sixteen day trip will be made into Alaska.

UNIVERSITY AND EDUCATIONAL NEWS

DR. K. G. MATHESON, president of the Georgia School of Technology, announces that the sum of $1,222,857 has been contributed toward the fund of $5,000,000 which the institution has undertaken to raise for permanent buildings and equipment.

DR. WADE H. FROST, former surgeon in the United States Public Health Service, has been appointed head of the department of epidemiology and public health administration in the School of Hygiene and Public Health of the Johns Hopkins University.

LIEUTENANT-COLONEL HARDEE CHAMBLISS, since 1919 commanding officer of the U. S. nitrate plant at Sheffield, Ala., has been appointed to take charge of the work of the department of chemistry at the Catholic University owing to the prolonged illness of the Reverend Dr. John J. Griffin, who has been in charge of the department since its opening in 1895.

DR. ROBERT H. LOWIE is leaving the American Museum of Natural History, where he has been associate curator in the department of anthropology, to accept the position of associate professor of anthropology at the University of California.

DR. BERTRAM G. SMITH, of the Michigan State Normal College, has been appointed associate professor of anatomy, in charge of embryology and histology, in the New York University and Bellevue Hospital Medical College.

DR. CHESTER A. MATHEWSON, for seven years head of the department of science in the Maxwell Training School for Teachers, Brooklyn, N. Y., has been appointed head of the department of biology in the School of Education at Cleveland, Ohio.

IN the Oregon Agricultural College, H. H. Gibson, professor of vocational agriculture in the University of Arizona, has accepted the headship of the department of agricultural education. He was formerly director of agricultural education in the University of Vermont. John R. Du Priest, professor of steam and gas engineering and design in the Rensselaer Polytechnic Institute, Troy, N. Y., has been appointed assistant professor of mechanical engineering.

DISCUSSION AND CORRESPONDENCE

A DEFENSE OF PROFESSOR NEWCOMB'S LOGIC

TO THE EDITOR OF SCIENCE: To those acquainted with Professor Simon Newcomb's mental habits and with Professor Comstock's usual preciseness of language, the latter's criticism of Newcomb's statement concerning ultra-mundane life is puzzling (SCIENCE, July 8, 1921). After several readings I venture the opinion that he appears to impugn the logic which he seems to think Newcomb might have used in coming to the conclusion that "to suppose" countless worlds are inhabited "is perfectly reasonable." Is there a chance that Professor Comstock may be the victim of his own false premise, contained in the sentence with which he starts upon this phase of the subject: "As to the numerous worlds alleged (*sic*) to be the abode of life, Newcomb in his essay . . ." says so and so. If we may trust the dictionaries, *to allege* is to make a positive assertion, or a statement which the alleger is under obligations to prove; whereas *to suppose* is to "conceive a state of things . . . , but not free from doubt" (*Century Dictionary*). So far as my search has gone, Newcomb has not at any time alleged or asserted the existence of animal life in other worlds; he has merely supposed, and said that such supposition "is perfectly reasonable." A reading of his admirable essay on the subject ("Life in the universe," in "Side-Lights on Astronomy," 1906) should, in my opinion, convince of the reasonableness.

W. W. CAMPBELL

MOUNT HAMILTON, CALIFORNIA,
July 16, 1921

BIOLOGICAL CONTROL OF DESTRUCTIVE INSECTS

TO THE EDITOR OF SCIENCE: Control of destructive insects by the introduction of their

natural enemies has become an important technique during the last generation. But if competent observers are to be trusted, the southern Arabs employed the same method more than 150 years ago, in the culture of the date-palm.

In his "Relation d'un Voyage dans l'Yemen" (Paris, 1880, p. 155), P.-E. Botta says:

> I was able to verify the singlar fact previously observed by Forskål, that the date-palms in Yemen are attacked by a species of ant which would cause them to perish, if each year the growers did not bring from the mountains and fasten in the tops of the palms branches of a tree that I did not recognize, which contain the nests of another species of ant which destroys that of the date-palm.

P. Forskål was the naturalist of C. Niebuhr's expedition; his work was published posthumously in 1775. I have not seen his account to which Botta refers.

It would be interesting to know whether the history of economic entomology furnishes any earlier record of the "biological method" of pest control.

PAUL POPENOE

THERMAL, CALIF.,
April 24, 1921

A LONGLIVED WOODBORER

FROM its burrow in the top piece of an old birch book-case at Mt. Pleasant, Iowa, a soft white wood-boring grub was shaken recently, when the owner discovered the newly made opening and conical pile of wood chewings that had been thrust out. There is nothing unusual about finding grubs in wood, but this particular wood-boring larva has a strange history.

The matured larva was given to the writer and placed in a box to complete its development. It pupated in about two weeks and in a few days the adult beetle emerged. It was *Eburia quadrigeminate* Say, a longicorn commonly known as the honey-locust borer, and is recorded as developing in hickory, ash and honey locust.

Mrs. Doe, who owns the book-case, is certain that the board in which the grub fed and grew from egg to a matured larva is no less than forty years old, as the book-case has been in the possession of the Does for at least that many years.

Just how and why this creature should have spent so many years in this humdrum life between the narrow walls of a thoroughly seasoned birch board only five eighths of an inch thick, and never once coming out for air or water seems remarkable indeed.

Mr. J. McNeil, writing in the *American Naturalist*,[1] tells of two longicorns of this same species emerging from an ash door-sill that had been in place nineteen years. In that case the relation of the tunnels to the solid brick wall on which the door-sill rested seems to have made it certain that the eggs were laid in the wood before the house was built. This case seems to outstrip any known insect record in point of longevity.

H. E. JAQUES

IOWA WESLEYAN COLLEGE,
MT. PLEASANT, IOWA

QUOTATIONS

THE COST OF PRINTING SCIENTIFIC WORKS IN ENGLAND

OFFICERS of learned societies and librarians have made public a memorandum planned to impress on the printing and publishing firms of the United Kingdom the danger which they are incurring by enforcing the recent enormous increase in the price of books, more especially books of the more serious and specialized sort. They say:

> It is not only to the public detriment, but clearly also to the detriment of the printing and publishing trades, that learned societies should be forced to cut down or suspend altogether their output of proceedings and monographs, and that libraries should have to reduce to a minimum the number of books which they purchase. It is obvious that if books are bought in ever-decreasing numbers, publishers will find it useless to print anything, however valuable, which does not appeal to the unlearned public. And if societies are

[1] Vol. XX., p. 1055.

unable to continue their series of publications there will be less work for printers. More money can not be raised either by societies, whose members mainly come from those professional classes which the war has hit most hardly, or by libraries which depend on private funds drawn from those same classes.

We are aware that material costs more, and that printers' labor is now remunerated on a scale which has forced publishers to raise all prices. But the general economic conditions which led to these phenomena are beginning to change. The existing scale of book prices means the cessation of book-buying. Unless novels and school books are to be the only output of the future, the present state of things must come to an end. The remedy lies with the trade; the buying public has come to the end of its resources, and refuses to be exploited any longer.

To this statement Mr. Geoffrey S. Williams, president of the Publishers' Association of Great Britain and Ireland, makes reply in the *Times,* saying:

It is unfortunate that the signatories of the manifesto about the cost of printing should have included publishers in their indictment, for publishers are fellow-sufferers with the signatories. They are dependent on the printing, binding, and paper-making trades, and until the charges made by these trades are materially reduced it is quite impossible for publishers to issue books at lower prices. On the whole, prices of books have not advanced to anything like the extent that would have been justified by the increases in the costs of production.

It is not easy to quote figures, for books, like human beings, have distinct individualities, especially from the publisher's point of view; hardly any two of them are exactly alike, though they wear the same clothes; but from calculations that have recently been before me, and give, I believe, a very fair comparison of the prices ruling in 1914 and now, it appears that the cost of printing is approximately two and three-quarter times what it was in 1914, paper (of an inferior quality) costs over double what it did in 1914, binding (also of an inferior quality) costs rather more than three times what it did in 1914, while the total cost of a large edition of a small book works out at about 180 per cent. above the 1914 figure, and publishers' establishment charges and the cost of advertising have kept pace with other items in their upward course.

SPECIAL ARTICLES

A BACTERIAL DISEASE OF GLADIOLUS

AN undescribed bacterial disease of *Gladiolus* has been under observation in this laboratory for a number of years, and recently a more intensive study has been undertaken. The following brief description is offered as preliminary to the publication of the complete study.

The organism has been isolated repeatedly and its pathogenicity proved by inoculation of healthy plants. The parasite is briefly characterized as follows:

Bacterium marginatum n. sp.

A cylindrical rod varying considerably in length, $1\text{–}3.5 \times 0.5\text{–}0.8\,\mu$, frequently in pairs and forming chains in beef bouillon; motile by means of 1–2 polar flagella; aerobic, no spores, capsules present.

Superficial colonies in peptone-beef agar plates are very characteristic; circular, smooth, slightly elevated centers surrounded by a wide thin border more or less irregular at the margin. Width and character of the border vary slightly under different conditions. Growth is white and extremely viscid.

Liquefies gelatin; liquefies blood serum; does not reduce nitrates; produces slight acidity in milk; digests casein; produces acid in cultures with various sugars. Grows well in Cohn, Fermi and Uschinsky's solutions. Produces moderate amounts of indol and ammonia. No gas is formed.

Temperatures for growth, maximum 40° C., minimum 8–9° C., optimum 28–30° C. Thermal death point about 52° C. Does not grow at temperatures below 8° C., but remains alive for at least 8 weeks at 1–2° C.

Gram negative. Group number: 211.2222022.

Pathogenic in leaves of gladiolus forming circular to elliptical lesions rusty red in color becoming dull brown or purplish. These spots may occur on all parts of the foliage but are often confined to the lower leaves. Observation and experiment indicate that the disease makes rapid and dangerous progress only in warm and moist weather when the rot spreads

widely and deeply into the tissues, causing the collapse of the aerial part of the plant.

The disease caused by these bacteria is very prevalent in and about the District of Columbia. In the fields examined, 80–90 per cent. of the plants were affected but in the majority of these cases not so severely as to noticeably arrest the development and bloom of the plant.

Plants with the same disease have been received from Illinois with the information that it has caused loss to the growers. Some *Gladioli* from California apparently had the same disease but the case was not completely proved.

Lucia McCulloch,
Bureau of Plant Industry,
U. S. Department of Agriculture

THE AMERICAN CHEMICAL SOCIETY

(*Continued*)

SECTION OF SUGAR CHEMISTRY AND TECHNOLOGY

C. A. Browne, *chairman*
Frederick Bates, *secretary*

A rotary digester for use in bagasse analysis: G. L. Spencer. A rotary digester is described for the digestion and extraction of bagasse for purposes of analysis. 100 grams of chopped bagasse are weighed in a tared cylinder: 1 liter of hot water is added. If ammonia is used for preserving the bagasse, no alkali is added to the digestion water, otherwise sodium carbonate is added. The cylinders are closed and revolved in the digester for an hour while steam is turned into the casing. The steam is then shut off, cold water is admitted to the casing and the revolution continued until the sample is cooled. The cylinders are then removed, dried and weighed, the rest of the procedure being the same as in the customary methods of analysis.

Determination of reducing sugars in lead preserved cane juices: J. B. Harris. Samples of raw cane juices for purposes of factory control are composited and preserved with dry lead subacetate. In the determination of reducing sugars, the preserved juice gives results about 10 per cent. too low where sodium oxalate or other normal salts are used to delead. Experiments with various deleading agents show it to be necessary to change reaction of preserved juice to acid in order to recover the reducing sugars combined with the lead. Best results are obtained with oxalic acid as a deleading agent, as it always gives the same results on the preserved juice as are obtained on the same juice without the use of lead or any deleading agent.

Dry substances in molasses, syrups and juices by the Spencer electric oven: George P. Meade. The Spencer electric oven is an apparatus originally devised for rapidly drying granular and fibrous substances, such as sugar, bagasse, etc., by drawing a large amount of heated air through the material to be dried. On suggestion of the inventor, Dr. G. L. Spencer, a method has been worked out for liquid sugar products by absorbing the liquid on asbestos as in the Babcock method for drying milk. With a ten minute heating period, known solutions of sugar, and of invert sugar and salt, are dried quantitatively to one part in 300 or better. Thick solutions, such as molasses and honey, must be diluted with water, one to one by weight. Duplicate tests on many different kinds of molasses, and on honey and cane juice, show close agreement.

Two simple tests for the control of the crystallizer and centrifugal machine work: M. J. Proffitt.

A comparison of the results in the process of desugarization with the Steffen lime process, the barium process and the strontium process: M. Potvliet. The desugarization appears to be in favor of the barium process. The real purity of the juices after deduction for raffinose is highest in the barium process. No raffinose is eliminated either in the Steffen lime process or in the strontium process, whereas in the barium process approximately 50 per cent. of the raffinose is removed into the waste water. The removal of the raffinose is important in view of the discarding of molasses. Of the 48.5 per cent. real sugar in the worked molasses, there was obtained: in the lime process 35.45 per cent. as granulated, 8.05 per cent. in molasses and 5.00 per cent. in waste water; in the barium process 43.97 per cent. as granulated, 2.91 per cent. in molasses and 1.62 per cent. in waste water; in the strontium process 43.18 per cent. as granulated, 4.32 per cent. in molasses and 1.00 per cent. in waste water. The rather heavy waste water of the barium and strontium processes can easily be concentrated to 42° Bé, whereas the very diluted Steffen waste water with large amounts of soluble lime compounds causes many difficulties. Waste water with 42° Bé contains about 12 per cent. K_2O and 4 per cent. N.

The effect of varying hydrogen-ion concentration upon the decolorization of cane juice with carbon: J. F. BREWSTER and W. G. RAINES.

The effect of some decolorizing carbons on the color and colloids of cane juice: J. F. BREWSTER and W. G. RAINES.

The determination of color and decolorization in sugar products: H. H. PETERS and F. P. PHELPS. The degree of color introduced and decolorization obtained for sugar solutions was determined with a spectrophotometer. The difficulties encountered to create filtrates "optically void" out of impure sugar solutions led to the adoption of an analytical procedure. It is shown that the commonly practised mode of analytical preparation for colorimetric analyses leads to erroneous conclusions in regard to color introduced and removed; that consistent results can not be attained as the present criterion for "brilliant filtrates" is far from being synonymous with "filtrates optically void." Inert material employed in the analytical preparation, such as Kieselguhr, must not be used. It leads to selective action on different wave lengths; neither is its most brilliant filter-paper-filtrate "optically void." The final calculation of color in sugar products to a unit basis of "100 Brix, 1 cm." is proposed. The laws governing the application of the spectrophotometer and tint photometer are discussed and directions are given how to express color degrees obtained by other colorimeters on this unit basis. Graphs of transmission and absorption spectra are presented.

A discussion of the refractometer scale for the evaluation of syrups: F. C. ATKINSON. A discussion of the relative merits of both methods for the grading of glucose and other viscous syrups, being an argument for the adoption of the refractometer reading as the official standard for the commercial valuation of such syrups. This argument is based on the higher degree of accuracy, convenience and saving of time over the method now in vogue.

Preparation of mannose from ivory nut shavings: PAUL M. HORTON. In making mannose from ivory nut shavings, the syrup is usually gummy and difficult to crystallize. If, however, the shavings are extracted with sodium hydroxide before being hydrolyzed with sulphuric acid, the final syrup crystallizes from glacial acetic acid without difficulty. If crystallization is slow, it can frequently be hastened by freezing the solution under agitation and thawing slowly. Details as to concentration and temperature are also given.

Flask calibrating and marking device: G. L. SPENCER.

The preparation of a decolorizing char from sugar cane bagasse: C. E. COATES.

A revision of the optical method for analyzing mixtures of raffinose and sucrose: C. A. BROWNE and C. A. GAMBLE. Recent corrections by Steuerwald and by Schrefeld of the Clerget formula for the Herzfeld method of determining sucrose necessitate also a revision of the Creydt formulas for analyzing mixtures of raffinose and sucrose. In making this revision, the authors have redetermined the value of the constant for the invert polarization of raffinose and have also determined the values for the influence of temperature upon the polarizations of raffinose before and after inversion. Applications are given of the Creydt formulas as thus revised to the analysis of mixtures containing known amounts of sucrose and raffinose.

Preliminary note on the causes of caking in sugar: M. J. PROFFITT.

Investigation of conditions affecting the quantitative determination of reducing sugars by Fehling solution. Elimination of certain errors involved in current methods: F. A. QUISUMBING and A. W. THOMAS.

The standardization of rare sugars: H. T. GRABER.

The determination of ash in Cuban raw sugar: UEL S. JAMISON and JAMES R. WITHROW. Difficulty from foamover in ash determination can be eliminated by preliminary heating on electric hot plate before ashing in the usual muffle. A drop or two of vaseline oil also prevents foamover. The sulfate method of ashing used by the Bureau of Standards is found on Cuban raw sugar to give 38 per cent. higher results even with the usual 10 per cent. modification than its direct incineration. The various other ashing methods in the literature have been compared and a modification of the sulfate method suggested.

The quantities and properties of lead precipitates from different raw cane sugars: C. A. BROWNE and H. M. WILEY. A comparison is given of the specific gravities and PbO content of the dried sugar-free lead subacetate precipitates obtained from 3 Cuban centrifugal sugars and 4 Philippine concrete sugars. The lead precipitates from the Cuban sugars had an average sp. gr. of 2.47 and a PbO content of 46.85 per cent., and from the Philippine sugars an average sp. gr. of 2.74 and a PbO content of 49.56 per cent. For a normal

weight of 26 grams of sugar in 100 c.c. the volumes of the lead precipitates in the case of the Cuban sugars of polarization 90.95–96.00 varied from 0.10 to 0.12 c.c. and in case of the Philippine sugar of polarization 78.30–87.80 from 0.32 to 0.48 c.c. The volume of the lead precipitates was not found to increase during deterioration of the sugar.

1. *The saccharimetric graduation of polarimeters with a graduated circle which employ yellow sodium light.* 2. *The graduation of saccharimeters with a quartz compensation:* A. JOBIN. The author employs as a basis for the saccharimetric graduation of his instruments the following fundamental values: $+66.5$ for the specific rotation of sucrose for the D ray; $+21.7182$ for the rotation of the standard 1 mm. plate of quartz for the D ray. The variations in these fundamental values with concentration of sugar solution, with temperature and with source of light are considered, and a mathematical discussion is given of the various corrections which need to be applied in the saccharimetric graduation of polarimeters and of quartz wedge saccharimeters. Light filters should serve not for unifying, but for purifying the source of illumination. The official rules relating to the bichromate filter should be revised.

Examination of sugar crystals by projection: GEORGE P. MEADE. Samples of raw sugar from several factories are classified daily as to size and regularity of crystal. A "balopticon," with vertical attachment, throws an image of a small portion of the sample on a screen, magnifying ten diameters. Squares drawn on the screen correspond in size to an arbitrary scale of ten, and the observer compares the image of the crystals with the squares, determining the size to the nearest whole number of the scale. The projection also shows the regularity and form of the crystals, and abnormalities are noted.

The rare sugars, their purity and tests: R. B. BLACK.

A study of beet gum. (1) *Separation from final molasses:* H. S. PAINE and C. F. WALTON.

Solubility of dextrose in water: R. F. JACKSON and C. L. GILLIS.

Some observations from the beet sugar industry: H. E. ZITKOWSKI.

Sugar filtration in factories and refineries: H. J. RUNYON, JR.

Colloids in beet sugar house liquors and products: H. S. PAINE, C. G. CHURCH and F. W. REYNOLDS.

Experiments with sugar cane seedlings in St. Croix: LONGFIELD SMITH. Experiments conducted during 1920 upon the St. Croix seedling canes—S. C. 12/37, S. C. 12/4, S. C. 14/93, and S. C. 13/13—gave in comparison with the standard ribbon cane grown for comparison alongside the following yields of cane and of sucrose per acre, as obtained by a small 3 roller mill driven by a 5 h.p. gasoline engine.

	Tons Cane per Acre	Pounds Sucrose per Acre
S. C. 12/37..........	35.7	7460
Ribbon alongside	27.3	5157
S. C. 12/4...........	31.5	6970
Ribbon alongside	28.4	5771
S. C. 14/93..........	36.9	6671
Ribbon alongside	31.5	5306
S. C. 13/13..........	38.3	6455
Ribbon alongside	32.1	6248

With a stronger mill such as used in a modern sugar factory the above yields of sucrose per acre would be at least 50 per cent. higher. The new St. Croix seedlings are excellently adapted to local conditions and are rapidly finding favor not only in St. Croix but in Porto Rico and other West Indian islands. The S. C. 12/4, when ripe, yields a juice containing 20 per cent. sucrose. The juice of ripe ratoons has been known to yield 24 per cent. of sucrose.

A precipitate obtained from cane juice after clarification with Kieselguhr and decolorizing carbon: V. BIRCKNER.

Experiments with Schoorl's volumetric method for determining reducing sugars: C. A. BROWNE and G. H. HARDEN. In Schoorl's volumetric method for determining reducing sugars, the unreduced copper of the Fehling solution is determined in presence of the reduced Cu_2O by means of $n/10$ thiosulphate solution after acidifying with sulphuric acid and adding potassium iodide. The difference between the total copper originally present and the unreduced copper gives the copper reduced by the sugar. Applications of this method to the analysis of solutions of dextrose, maltose, lactose and sucrose are given, with comparisons of the results obtained by direct weighing of the reduced copper.

The continuous sampling of sugar liquors: W. L. JORDAN.

Preparation of galactose: E. P. CLARK.

The manufacturing of high purity crystalline anhydrous dextrose: C. E. G. POYST.

CHARLES L. PARSONS,
Secretary